NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
AND GENERAL SPECIFICATIONS

RIPARIAN FOREST BUFFER

(Acre)
CODE 391

DEFINITION

An area of trees and/or shrubs and grasses located adjacent to and up-gradient from streams or water bodies.

PURPOSES

- Reduce excess amounts of sediment, organic material from livestock waste, nutrients, pesticides and other pollutants in surface runoff, and reduce excess nutrients and other chemicals in shallow ground water flow.
- Improving water quality by establishing permanent tree and herbaceous cover on floodplain areas subject to out-of-bank flow and/or scour erosion.
- Create riparian habitat and corridors for wildlife.
- Create shade to lower water temperatures to improve habitat for fish and other aquatic organisms.
- Be a source of detritus and large woody debris for fish and other aquatic organisms.

CONDITIONS WHERE PRACTICE APPLIES

On areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands (including seasonally inundated oxbows), sinkholes, tile inlets agricultural drainage wells and other areas with ground water recharge.

CRITERIA

General Criteria Applicable To All Purposes.

The location, layout, width, length and woody plant density of the riparian forest buffer will accomplish the intended purpose and function. See General Specifications for required plant densities for buffer plantings.

The buffer will consist of two zones.

Zone 1

Zone 1 is a tree/shrub zone that begins at the upper edge of the active channel or shore, and extends a minimum distance of 40 feet, measured horizontally on a line perpendicular to the water course or water body.

Vegetation in Zone 1 will consist of at least two rows of trees and/or shrubs suited to the site and the intended purpose. Where shrubs only are used, use a minimum of three rows. Woody vegetation along stream banks may be shorter and more flexible to better absorb flood energies. A non-competitive, perennial ground cover will be established in Zone 1. Suitable species include perennial ryegrass, orchardgrass, timothy, red clover, alsike clover, and ladino clover. Legumes should not be more than 50 percent of any mixture.

Where streambanks are unstable, use all practical measures to stabilize the streambank. Refer to the Standard for Streambank and Shoreline Stabilization (580) for information on stabilizing streambanks. If it is not practical to

stabilize the streambank, the buffer width should be increased by three times the height of the stream bank. This additional width will be added to Zone 1 and planted to trees and/or shrubs.

Zone 1 must comprise at least one third of the total width of the riparian forest buffer.

Selection of locally native species will be a priority when feasible. Plantings will consist of two or more species with individual plants suited to the seasonal variation of soil moisture status of individual planting sites (see Figure 1). Mixing plant species within rows, and between rows, will tend to reduce insect and disease problems. Plant types and species shall be selected based on their compatibility in growth rates and shade tolerance. Refer to Section II, Forestland Interpretations and Windbreak Interpretations of the Field Office Technical Guide for acceptable species.

Zone 2

Zone 2 will begin at the up-gradient edge of Zone 1 and extend a minimum of 20 feet perpendicular to Zone 1.

Zone 2 will be seeded to stiff stemmed grasses suited to the site and intended purpose. Refer to the Standard for Conservation Cover (327). Native warm season grasses are preferred. Do not use Reed canarygrass, Kentucky bluegrass, or Tall fescue. When riparian forest buffers are located in non-cropland, Zone 2 will not be required as long as there is a minimum of 20 feet of existing grass between Zone 1 and cropland fields.

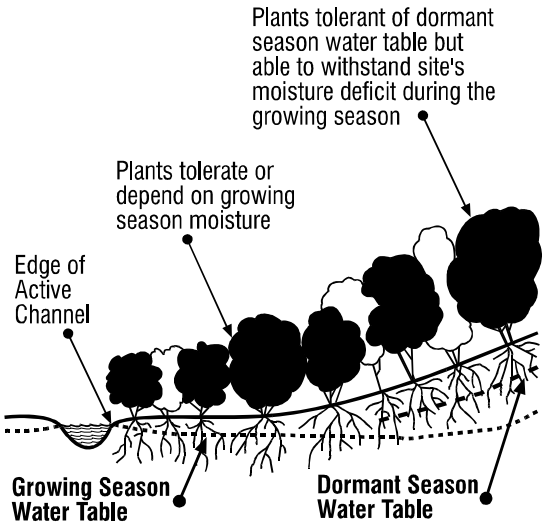

Figure 1. Plant adaptation to soil moisture.

In all cases, widths listed in this standard may be established on one or both sides of the stream.

Where ownership conflicts restrict the design width of the buffer, each zone should be reduced in width, proportionately.

Necessary site preparation and planting for establishing new buffers shall be done at a time, and in a manner, to ensure survival and growth of selected species.

The method of planting for new buffers shall include hand or machine planting techniques or direct seeding, be suited to achieving proper depths and placement of planting stock roots, and shall not impair the intended purpose and function of the buffer. If direct seeding is selected, use appropriate seed collection, storage, and planting methods. When direct seeding is used, work with the local DNR Forester in evaluating the site and appropriate species to plant. Species suitable for direct planting are ash, maple, black walnut, oak, or hickory.

Livestock shall be permanently excluded from Zone 1. Controlled grazing of Zone 2 will be permitted as long as minimum stubble heights are maintained and Zones 1 and 2 are separated by a fence. Water course crossings and livestock watering shall be located and sized to minimize impact to buffer vegetation and function.

Impairment of buffer function by livestock overuse (trampling or compaction) shall require immediate removal of livestock from the riparian area.

Special considerations are needed where waterways, concentrated flow areas, or subsurface drains pass through the buffer. Plant a strip of cool season grasses (**not reed canarygrass**) in concentrated flow area. This strip should be equal to the design width of the waterway or equal to the width of the concentrated flow area. Where tile lines are not present in the concentrated flow area, tall stiff stemmed grasses such as switch grass should be encouraged.

Where tile lines run through the buffer, a 12-24 foot strip of cool season grasses (**not reed canarygrass**) shall be centered over the tile line.

Trees shall not be placed closer than the height of the mature tree to the tile line. For example, if the mature height of a silver maple is estimated to be 60 feet, than silver maple shall not be planted closer than 60 feet to the tile line. The remaining area between cool season grass strip and any tree planting, as appropriate, shall be planted to a combination of tall warm season grasses and/or shrubs.

Harmful pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose. Cultural and biological methods of pest control should be employed whenever possible.

ADDITIONAL CRITERIA TO IMPROVE WATER QUALITY BY ESTABLISHING PERMANENT TREE AND HERBACEOUS COVER ON FLOODPLAIN AREAS SUBJECT TO OUT-OF-BANK FLOW AND/OR SCOUR EROSION.

Widths of Zones 1 and 2 will be increased to include areas to overland flow and/or scour erosion, up to the width of the 100 year floodplain, Evidence of these conditions includes residue or debris deposits, scour channels, aerial photographs, and field observations.

ADDITIONAL CRITERIA TO REDUCE EXCESS AMOUNTS OF SEDIMENT, ORGANIC MATERIAL, NUTRIENTS, PESTICIDES AND OTHER POLLUTANTS IN SURFACE RUNOFF, AND REDUCE EXCESS NUTRIENTS AND OTHER CHEMICALS IN SHALLOW GROUND WATER FLOW.

Where reduction of sediment, organic material, nutrients, pesticides, or other pollutants is the objective, Zone 2 will meet the following minimum widths in feet:

Land slope at the buffer site (%)

	0.5	1.0	2.0	3.0	4.0	5.0
Warm Season - Min	20	25	35	45	55	60
Cool Season - Min	40	50	70	90	110	120

At least one third of the total buffer area must be trees and/or shrubs. The minimum combined (Zones 1 and 2) buffer width shall not be less than 66 feet. Buffers less than 66 feet wide do not provide enough residence time in the root zone to remove unwanted chemicals from the water.

ADDITIONAL CRITERIA TO CREATE RIPARIAN HABITAT AND CORRIDORS FOR WILDLIFE.

When the purpose of the riparian forest buffer is to create riparian habitat and corridors for wildlife species, follow the guidelines below for buffer width. Where buffers extend beyond riparian boundaries, refer to Tree/Shrub Establishment (612) for design of upland forests.

Species:	Desired Width in feet:
Bald eagle, cavity nesting ducks, turkey, quail, grouse	600
Beaver, dabbling ducks, mink, salmonids	300
Deer	200
Frog, salamander	100

ADDITIONAL CRITERIA TO CREATE SHADE TO LOWER WATER TEMPERATURES TO IMPROVE HABITAT FOR FISH AND OTHER AQUATIC ORGANISMS.

A buffer to lower warm-season water temperatures shall be established or maintained on south and west sides of water courses and bodies insofar as practical. The buffer canopy shall be established to achieve at least 50 percent crown cover with average canopy heights equal to the lesser of width of the water course or 30 feet. See Figure 2.

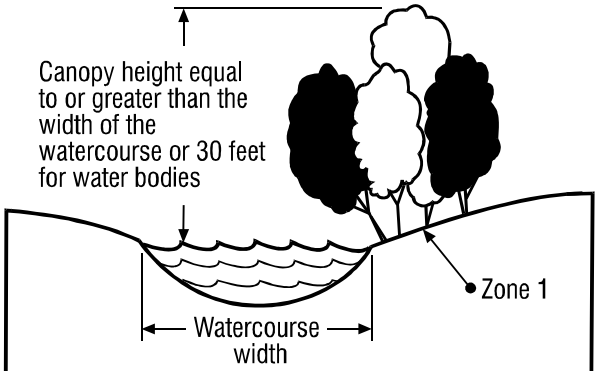

Figure 2. Canopy height for water temperature control.

Buffer species shall include those species listed in the Field Office Technical Guide, Section II Windbreak Interpretations, with sufficient height potential. Place drooping or wide-crowned trees and shrubs nearest the water course or body. Shoreline or channel relief (e.g., deeply incised channels) and topographic shading will be taken into account in selecting species.

ADDITIONAL CRITERIA TO PROVIDE A SOURCE OF DETRITUS AND LARGE WOODY DEBRIS FOR FISH AND OTHER AQUATIC ORGANISMS.

Within Zone 1 as a minimum, establish, favor, or manage species capable of producing stems and limbs of sufficient size to provide an eventual source of large woody debris for in-stream habitat for fish and other aquatic organisms.

ADDITIONAL CRITERIA FOR NON-CROPLAND AREAS THAT CONTAIN REMNANTS OF NATIVE PRAIRIE VEGETATION.

Riparian forest buffers that are to be established on non-cropland areas that contain remnants of native prairie vegetation will use woody vegetation at low density.

These areas will be identified by NRCS in consultation with Iowa Department of Natural Resources Forester and Wildlife Biologist.

Low density woody vegetation is an established density of 50 - 100 woody plants per acre. Only native woody vegetation will be used on these sites. (Refer to Tables 1-3 for native woody plants).

Native woody forbs or shrubs shall be used where site conditions allow. Native woody vegetation may consist of native woody forbs (such as leadplant and prairie rose), native shrubs, or trees.

Natural revegetation may be used on sites that are determined to have a seed source adequate to establish a minimum of 50 woody plants per acre within two years.

Caution will be used when planting woody vegetation. Avoid planting directly into the native prairie remnants. Leave at least 10 feet between woody plantings and native prairie remnants.

CONSIDERATIONS

The severity of bank erosion and its influence on existing or potential riparian trees and shrubs should be assessed. Watershed-level treatment or bank stability activities may be needed before establishing a riparian forest buffer.

Complex ownership patterns of riparian areas may require group planning for proper buffer design, function, and management. Consider the implications to other property owners of installing a buffer on only one side of a channel.

Favor tree and shrub species that are native and have multiple values such as those suited for timber, biomass, nuts, fruit,

browse, nesting, aesthetics and tolerance to locally used herbicides. **Consider species that re-sprout when establishing new rows nearest to water courses or bodies.**

Avoid tree and shrub species, which may be alternate hosts to undesirable pests or that, may be considered noxious or undesirable. **Species diversity should be considered to avoid loss of function due to species-specific pests.**

The location, layout, and density of the buffer should complement natural features.

Consider the positive and negative impacts beaver, muskrat, deer, rabbits, and other local species may have on the successful management of the riparian and stream system. Temporary and local population control methods of these kinds of species should be used cautiously and within state and local regulations. Where deer or beaver predation may be a concern, consider selecting tree and shrub species that are not preferred by deer and beaver.

Species selection criteria to improve aesthetics include seasonal foliage color, showy flowers and fruit, foliage texture, form and branching habit. The layout and design should be appropriate for the setting as determined by adjacent land uses.

PLANS AND SPECIFICATIONS

GENERAL SPECIFICATIONS.

Procedures, technical details and other information listed below provides additional guidance for carrying out selected components of the named practice. While this standard provides minimum widths and density, wider buffers are more effective and provide multiple benefits.

PLANTING DENSITIES.

Initial plant-to-plant densities for trees and shrubs will depend on their potential height at 20 years of age. Heights may be estimated based on: 1) performance of the individual species (or comparable species) in nearby areas on similar sites, or 2) predetermined and documented heights using Windbreak Interpretations, Section II of the Field Office Technical Guide. Planting density specifications are:

Plant Types:	In-row-Spacing (ft)	Between Row Spacing (ft)
• Shrubs	5 to 7	9 to 12
• Trees	6 to 10	9 to 20

Wider row spacings are preferred to maintain ground cover under tree and shrub plantings.

Minimum established density should be 300 trees per acre and 400 shrubs per acre. Where wider rows are used, in-row spacing shall be closer, within the ranges given above.

PLANT LIST.

Refer to Table 1 for tree species commonly associated with and suited to riparian areas. See Table 2 for shrubs suited to riparian areas. Use practice standard Conservation Cover (327) to determine appropriate vegetative seeding mixtures. Refer to Section II of the FOTG for soil interpretations.

CARE, HANDLING, SIZE AND PLANTING REQUIREMENTS FOR WOODY PLANTING STOCK.

Planting stock will be stored in a cool, moist environment (34-38 degrees F) or heeled in. During all stages of handling and storage, keep stock tops dry and free of mold and roots moist and cool. Destroy stock that has been allowed to dry, to heat up in storage (e.g., within a bale, delivery carton or container), or that has developed mold or other pests. Live cuttings that will not be immediately planted shall be promptly placed in controlled storage conditions (34-38 degrees F) and protected until planting time.

Seedlings shall not be less than 1/4 inch in caliper at 1 inch above the root collar. For cuttings, avoid using material less than 3/4 inch in diameter, cut off tops with apical buds, remove side branches, and produce lengths long enough to reach adequate soil moisture required by the individual species during the growing season. Tops of dormant-season collected cuttings may be dipped into latex paint, paraffin, or sealing wax to prevent desiccation and mark the up-end. Rooted planting stock must not exceed a 2:1 shoot-to-root ratio.

Roots of bareroot stock shall be kept moist during planting operations by placing in a water-soil (mud) slurry or peat moss. Rooting medium of container or potted stock shall be kept moist at all times by periodic watering. Pre-treat stored cuttings with several days of soaking just before planting. Stock shall not be planted when the soil is frozen or dry. Rooted stock will be planted in a vertical position with the root collars approximately 1/2 inch below the soil surface. Insert cuttings to the depth required to reach adequate soil moisture with at least 2-3 buds above ground. The planting trench or hole must be deep and wide enough to permit roots to spread out and down without J-rooting or L-rooting. After planting of rooted stock or cuttings, pack soil around each plant firmly to eliminate air pockets.

OPERATION AND MAINTENANCE

Weed control.

Weed control is essential for survival and rapid growth of trees and shrubs. Options include 4-6 inches of organic mulch, weed control fabrics, shallow cultivation, or pre-emergent herbicides. Non-chemical weed control techniques are preferred because chemicals quickly can enter the water system in riparian areas. For larger plantings, pre-emergent herbicides, such as Goal, Surflan, or Oust may be needed for weed control (always read and follow label instructions). Glyphosate can be applied as a shielded spray for post-emergent weed control.

Continue weed control until woody plants occupy the area, normally two or three years. For more information about weed control, contact your state DNR forester.

Mowing.

The grass between the tree and shrub rows must be mowed once or twice during the growing season to mark rows. Late fall mowing also removes rodent habitat that helps minimize plant damage during winter months.

During the first year, cut warm-season grasses no shorter than 8 inches. Mow when weed growth exceeds 12 inches. The first year of establishment may require 2-3 mowings in the spring. It is important to mow before weeds get tall enough that the residue may smother new seedings. Mow the area again in mid to late September. Mowing reduces competition from weeds in the warm season grasses and helps them become established during their first year. If possible, burn the grass zone in early spring for 1-5 years until the grasses are well established.

Long-term management.

Buffers must be monitored and managed to maintain their maximum effectiveness. They should be inspected at least once a year, and always within a few days after severe storms. Look for evidence of sediment deposition, erosion, or concentrated flow channels. Repairs should be made as soon as possible.

After the first five years, the grass zone in the buffer can (and probably should) be harvested or burned on an annual or biannual basis. Periodic or regular removal of biomass promotes dense upper plant and root growth, which is needed to improve soil quality and filter pollutants. If a berm from tillage or sediment trapping develops along the field edge, a disk may be needed to pull soil back into the crop field from time to time.

If the warm season grass zone cannot be harvested, some of the grass can be removed by short, controlled grazing, using fences to keep livestock away from and out of the stream. Remember to consider

wildlife nesting periods and other needs when conducting maintenance.

Areas that have remnant native prairie areas shall be managed to encourage growth of the native vegetation. Management may include mowing (not shorter than 8 inches), prescribed burning (plan required), or chemical treatments.

The use of fast growing tree species (willow, cottonwood, poplar, silver maple, and green ash) ensures rapid growth and effective use of nutrients and other chemicals that could pollute water. To remove nutrients and chemicals stored in their stems; it may be necessary to harvest these fast-growing trees every 8-12 years. If longer rotations are desired, wider spacing within rows should be used. Periodic harvest also promotes continued vigorous growth. If harvested in winter, these species will regenerate from stump sprouts, thereby maintaining root system integrity and continued protection of the streambank.

A buffer strip with high value species, such as black walnut, red or white oak, or white ash, can be managed for sawlog production. Tree selection and thinning promote faster growth and higher quality material than trees allowed to grow without management.

Additional operation and maintenance requirements shall be developed on a site-specific basis to assure performance of the practice as intended.

REFERENCES

Schultz, R.C., J.P. Colletti, T.M. Isenhart, W.W. Simpkings, C.W. Mize, and M.L. Thompson. 1995. Design and Placement of a Multi-species Riparian Buffer Strip. Agroforestry Systems 29:201-225.

U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1991. Riparian Forest Buffers—Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. Prepared by: Monte E. Seehorn, Altanta, GA.

Extension Pm - 1626b. Stewards of our Streams, Buffer Strip Design, Establishment, and Maintenance.

Conservation Practice Job Sheet - Riparian Forest Buffer. USDA, Natural Resources Conservation Service.

Table 1. Tree species suited to riparian areas

Species	Rapid growth (nearest stream)	Biomass production	Timber (good drainage)	Timber (poor drainage)	Tolerant of deer predation	Tolerant of beaver predation	Native or Introduced
Hybrid poplar	X	X			Not	Not	Introduced
Hybrid Cottonwood	X	X		X	Not	Not	Introduced
Cottonwood	X	X		X	Not	Not	Native
Hybrid willow	X	X			Somewhat	Somewhat	Introduced
Black willow	X	X			Somewhat	Somewhat	Native
Silver maple	X	X		X	Resistant	Resistant	Native
Box elder	X	X			Tolerant	Resistant	Native
Basswood			X		Tolerant	Resistant	Native
Black walnut			X		Resistant	Resistant	Native
Red oak			X		Tolerant	Resistant	Native
Burr Oak					Tolerant	Resistant	Native
White oak			X		Tolerant	Resistant	Native
White ash			X		Resistant	Not	Native
Green ash	X	X		X	Resistant	Not	Native
Black ash			X	X	Resistant	Not	Native
River birch	X			X	Somewhat	Tolerant	Native
Shellbark hickory			X	X	Resistant	Resistant	Native
Hackberry			X	X	Resistant	Resistant	Native
Ohio buckeye			X	X	Resistant	Resistant	Native
Sycamore	X	X		X	Resistant	Resistant	Native
Swamp white oak			X	X	Resistant	Tolerant	Native
Eastern red cedar					Resistant	Resistant	Native

Table 2. Shrub Species Suitable for Riparian Buffers

Species	Native/Introduced
Amur Maple	Introduced
Arrowood	Native
Blackhaw	Native
Chokecherry	Native
Crabapple	Native
Cranberry bush	Native
Elderberry	Native
Gray dogwood	Native
Hawthorne	Native

Species	Native/Introduced
Hazelnut	Native
Nanking cherry	Introduced
Nannyberry viburnum	Native
Ninebark	Native
Redosier dogwood	Native
Sandbar willow	Native
Serviceberry	Native
Siberian peashrub	Introduced
Silky dogwood	Native
Wild plum	Native

Table 3. Other woody species appropriate for establishment in prairies.

Common Name	Scientific Name
Leadplant	Amorpha canescens
Indigo bush	Amorpha fruiticosa
Fragrant false indigo	Amorpha nana
New Jersey tea	Ceanothus americanus
Redroot	Ceanothus herbaceus
Prairie hawthorn	Crataegus mollis
Prairie crabapple	Malus ioensis
Prairie rose	Rosa arkansana
Meadow rose	Rosa blanda
Pasture rose	Rosa carolina

Number of Trees/Shrubs Per Acre

By Various Spacings

Spacing (Feet)	Plants (Number)	Spacing (Feet)	Plants (Number)	Spacing (Feet)	Plants (Number)
2x2	10890	7x9	691	12x15	242
3x3	4840	7x10	622	12x18	202
4x4	2722	7x12	519	12x20	182
4x5	2178	7x15	415	12x25	145
4x6	1815	8x8	681	13x13	258
4x7	1556	8x9	605	13x15	223
4x8	1361	8x10	544	13x20	168
4x9	1210	8x12	454	13x25	134
4x10	1089	8x15	363	14x14	222
5x5	1742	8x25	218	14x15	207
5x6	1452	9x9	538	14x20	156
5x7	1245	9x10	484	14x25	124
5x8	1089	9x12	403	15x15	194
5x9	968	9x15	323	15x20	145
5x10	871	10x10	436	15x25	116
6x6	1210	10x12	363	16x16	170
6x7	1037	10x15	290	16x20	136
6x8	908	10x18	242	16x25	109
6x9	807	11x11	360	18x18	134
6x10	726	11x12	330	18x20	121
6x12	605	11x15	264	18x25	97
6x15	484	11x20	198	20x20	109
7x7	889	11x25	158	20x25	87
7x8	778	12x12	302	25x25	70